Chapter 1
Introduction

1-1. Purpose

This manual provides information and criteria pertinent to the design and selection of hydroelectric power plant mechanical equipment and systems for new and rehabilitation projects. It is applicable to all such work within the U.S. Army Corps of Engineers responsibility.

1-2. Applicability

This manual is applicable to all HQUSACE elements, major subordinate commands, districts, laboratories, and separate field operating activities having responsibility for civil works projects.

1-3. References

Required and related publications are listed in Appendix A.

1-4. Limitations

a. Information covered in other manuals. The selection, procurement, and specification of certain major mechanical equipment are covered in other existing or pending engineer manual and guide specifications, including turbines, pump-turbines, governors, and mechanical aspects of generators. Information contained herein pertinent to such equipment is principally to aid in preparation of contract specifications based on the guide specification.

b. Detail design. This manual is not intended as a comprehensive, step-by-step solution to powerhouse mechanical design nor as a substitute for sound engineering resourcefulness and judgment. Used as a "guide post," not a "hitching post," it provides experience-oriented guidance and a basis for resolving differences of opinion among the competent engineers at all levels.

c. Material generally available. The manual stresses information that is of particular applicability to powerhouses. Other material useful in powerhouse mechanical design which is readily available in standard publications is not generally repeated or referenced herein.

1-5. Contents

This manual is divided into 18 chapters, each covering one or more closely related items of powerhouse mechanical equipment or system, a Chapter 19 on corrosion mitigation, and two appendices. Equipment and systems where the detail design responsibility is normally delegated to the contractor, or where other engineering manuals are applicable, are covered with the emphasis on application, selection, and specification aspects. Equipment and systems where the detail design is normally a Corps of Engineers office function are covered in greater detail or referenced to applicable standard design codes or handbooks. Appendix A lists references to other material such as guide specifications, codes, industry standards, and other engineering manuals provided throughout this manual as applicable. Appendix B contains specification excerpts, typical system schematics, and drawings of equipment and details typical of powerhouses and other information not readily available from commonly known sources.

1-6. Design Procedures

a. Standard procedures. Department of the Army Civil Works Guide Specification CE-4000 provides the standard procedure for development of a powerhouse design. These procedures include a Preliminary Design Report, Feature Design Memoranda, an Analysis of Design, Contract Drawings, Specifications, and Cost Estimates. CE-4000 prescribes the timing, preparation, and approval procedure for this material and also references other applicable manuals and guides. While the format and instructions of CE-4000 imply applicability only to Architect-Engineer design contracts, the design procedures noted therein should be followed by all district or division offices performing powerhouse mechanical design. Funding problems, fluctuations in planned manpower, and conflicts in design scheduling will tend to alter the prescribed order of procedures. However, all stated requirements should be met unless prior approval of an alternate procedure is obtained from higher authority.

b. Additional procedures.

(1) Shop drawing review. The checking of contractor shop drawings and other material for adequacy and compliance with specification requirements is normally assigned to the engineers who prepared the design.

(2) Operating instructions. The preparation of operating instructions for each item of equipment and system is normally a design office responsibility. This requires that all design considerations and assumptions be recorded and filed during the design development.

1-7. Other Design Information

a. Sources. Information which may be helpful in design is available from many sources other than prescribed Corps of Engineers material and standard handbooks. Design memorandums and drawings from other projects, manufacturers' catalog information, sales engineers, project operation and maintenance reports, field inspectors, operation and maintenance personnel, and the powerhouse electrical and structural design personnel are all valuable and readily available sources. Good communication with other Corps of Engineer District and Division offices can often expedite information on a particular problem.

b. Evaluation. Evaluation of available information should be approached with skepticism and judgment. Relying on previous satisfactory designs requires that the design conditions and requirements be carefully compared for applicability. The obtainment and evaluation of information from field sources is improved by the personal acquaintanceships and observations resulting from design engineer visits to under construction and operating plants as well as supplier plants. Office policies should permit and encourage these visits.

1-8. Deviations

Considerable flexibility in design is available to the design engineer within the manual provisions. It is recognized that new applications and techniques may justify deviations from the stated provisions. In such circumstances, advance consultation with higher authority is suggested.

1-9. General Design Practices

a. Factors during fabrication. Design should reflect the quality of materials, workmanship, and general quality control normally experienced. The engineer will not have absolute control over these factors during fabrication but can often make practical design concessions which will make the equipment or system less critical to deviations from specified tolerances.

b. Design computations. Design computations should be consistent with available data and assumptions. Precise computations are seldom justified with incomplete data and rough assumptions.

c. Simple designs. Designs should be as simple as practicable. Increased complexity for minor operational advantages is usually not warranted.

d. Backup requirements. Backup requirements should be evaluated both on the probability and effect of malfunction. Frequent, minor malfunctions can be expensive; a major-once-in-a-hundred year malfunction can be catastrophic.

e. Reducing personnel. The continuing emphasis on reducing operation and maintenance personnel should be reflected in designs requiring frequent operation and maintenance.

f. Generous tolerances. Tolerances and fits should be generous as practicable. Precision workmanship is expensive and undependable to obtain.

g. Design computations. The design computations should include the sources of all existing designs followed, sources of data, a record of alternate designs investigated, actual design computations used, and planned operating procedures. In providing design references, particularly where more than one reference is listed, a specific reference to the particular source is essential. A general listing of references potentially applicable to a system or item of equipment is of little value for review or record purposes. Providing specific references is essential in design memorandums as well as design computations in general.

h. Environmental quality. Incorporating environmental quality in project design is essential. Opportunities for enhancement through design will be vigorously sought. Specific ecological considerations in hydropower mechanical design include, but are not limited to, the use of environmentally safe lubricants, actions to preserve or enhance the survivability of fish (fish survival rate versus turbine efficiency), and actions to maintain or enhance water quality (location of the water intakes).

i Infestations. In areas with potential for zebra mussel contamination, many hydropower components, such as cooling systems, will be at risk of failure or disruption due to zebra mussel infestations. Design considerations in preventing these infestations should be included. For control strategies, refer to Zebra Mussel Research Technical Note ZMR-3-05, compiled by Zebra Mussel Research Program at Waterways Experiment Station.

1-10. Safety Provisions

Certain safety provisions will be required by guide specifications, trade standards, codes, and other manuals referenced herein. In addition, the requirements of the

Occupation Safety and Health Administration (generally referred to as OSHA Standards) are to be considered minimum requirements in Corps of Engineers design (see EM 385-1-1). Areas of particular concern, to mechanical design, are noise levels, personnel access provisions, working temperature conditions, air contamination, and load handling provisions. Modification and expansion of OSHA Standards are on a continuing basis, requiring conformance with the latest published requirements.